

M1.(a) (i) 2-hydroxypropanoic acid

OR

2-hydroxypropan(-1-)oic acid

Do not penalise different or missing punctuation or extra spaces.

Spelling must be exact and order of letters and numbers as here.

Can ignore -1- before -oic, but penalise any other numbers here.

1



Allow $4C_3H_6O_3$

OR

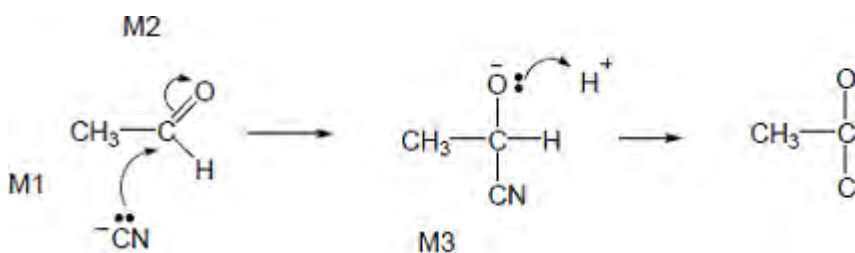


Allow $2C_3H_6O_3$

1

(b) (i) Nucleophilic addition

M4 for lp, arrow and H+



- M1 lp and minus must be on C
- M1 and M4 include lone pair and curly arrow.
- M2 not allowed independent of M1, but allow following some attempt at attack on carbonyl C
- allow M1 for correct attack on C+
- + rather than $\delta+$ on C=O loses M2
- M3 is for correct structure including minus sign but lone pair is part of M4
- Allow arrow in M4 to H of H-CN with arrow forming cyanide ion.

5

(ii) Equal mixture of enantiomers / (optical) isomers 1

(iii) (Plane) polarized light 1
If missing no further mark.

(Polarised light) rotated by single enantiomer but unaffected by racemate 1
Both needed; not allow bend, twist etc.

(c) (i) $\text{CH}_3\text{CH}(\text{OH})\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{COONa} + \text{H}_2\text{O}$ 1
OR $\text{CH}_3\text{CH}(\text{OH})\text{COOH} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{COO}^- + \text{H}_2\text{O}$
Not ambiguous mol formulae for product - must show COONa or CO₂Na or COO⁻ or CO₂⁻

(ii) $[\text{H}^+] = K_a$ **OR** $\text{pH} = \text{p}K_a$ 1

$\text{pH} = 3.86$ 1
Allow more than 2 decimal places but not fewer.

(iii) M1 buffer 1
Ignore acidic but penalise alkaline or basic.

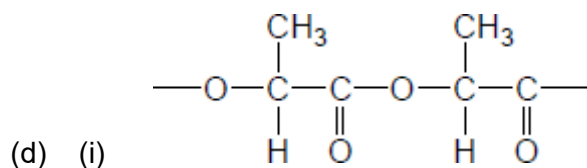
Any two out of the three marks M2 , M3 & M4

M2 Large lactate concentration in buffer
OR sodium lactate completely ionised

M3 added acid reacts with / is removed by lactate ion or A⁻ or sodium lactate or salt
OR equation $\text{H}^+ + \text{A}^- \rightarrow \text{HA}$
Ignore reaction of H⁺ with OH⁻
Ignore reference to equilibrium unless it is shown.

M4 ratio $[HA] / [A^-]$ stays almost constant
Ignore H^+ or pH remains constant.

Max 2



No marks if ester link missing

Correct ester link
allow $-COO-$

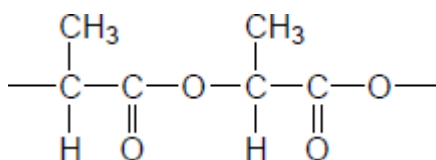
NB Correct answer scores 2

Ignore n here (compare with (d)(iv).

Ignore brackets

1

OR



All rest correct with trailing bonds

If OH or COOH on either or both ends, lose one, ie dimer scores 1

If more than two repeating units, lose 1

1

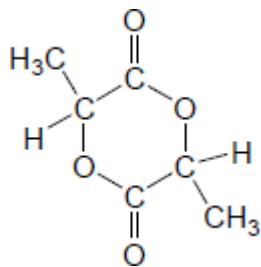
(ii) (Poly)ester ie allow ester

Not terylene.

Ignore spaces and brackets in answer.

1

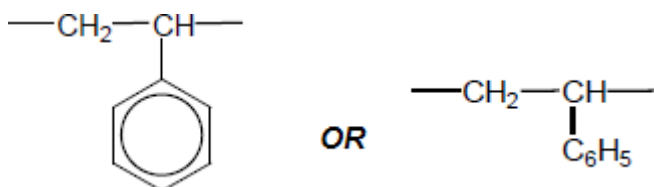
(iii)



Allow any cyclic $C_6H_8O_4$

1

(iv)



Penalise n here (compare with (d)(i))
Ignore brackets.
Not allow *Ph* for phenyl.

1

- (v) In landfill, no air or UV, to assist decay
OR not enough water or moisture (to hydrolyse polyester)

Allow landfill has / contains:

no or few bacteria / micro-organisms / enzymes compared with compost heap

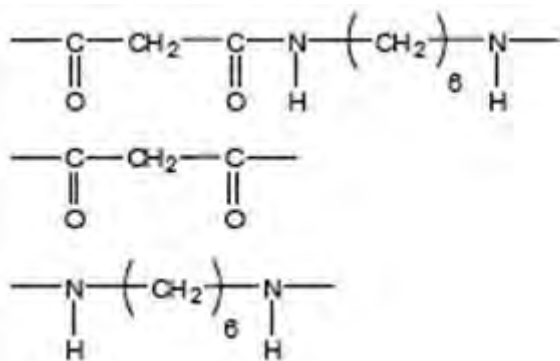
OR less oxygen

OR lower temperature.

1

[22]

M2. (a) (i)



Allow -CONH- or -COHN-

Mark two halves separately

lose 1 each for missing trailing bonds at one or both ends or error in peptide link or either or both of H or OH on ends

1

Not allow $\text{-(C}_6\text{H}_{12}\text{)-}$

Ignore n

1

(ii) **M1** in polyamides - H bonding

1

M2 in polyalkenes - van der Waals forces

Penalise forces between atoms or van der Waals bonds

1

M3 Stronger forces (of attraction) in polyamides

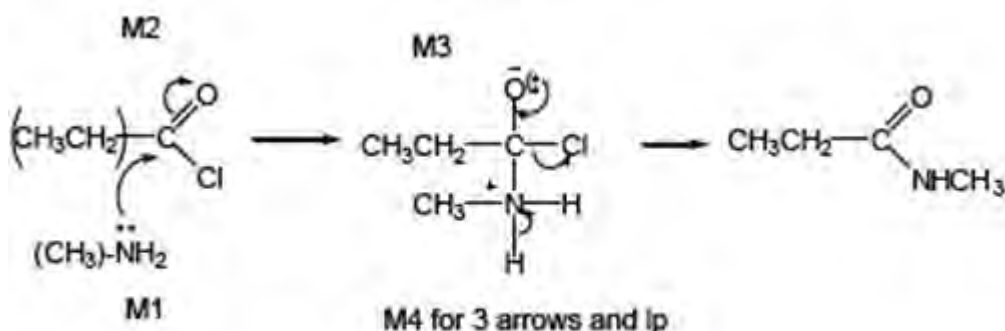
Or H bonding is stronger

(must be a comparison of correct forces to score M3)

Do not award if refer to stronger bonds

1

(b) (i) (nucleophilic) addition elimination



Not allow N-H_2

Minus sign on NH_2 loses **M1**

1

M2 not allowed independent of **M1**, but allow **M1** for correct attack on C^+

+ rather than δ^+ on $\text{C}=\text{O}$ loses **M2**

If Cl lost with $\text{C}=\text{O}$ breaking, max 1 for **M1**

M3 for correct structure with charges but

lp on O is part of **M4**

only allow **M4** after correct/ very close **M3**

For **M4**, ignore NH_3 removing H^+ but lose

M4 for Cl removing H^+ in mechanism,

but ignore HCl as a product

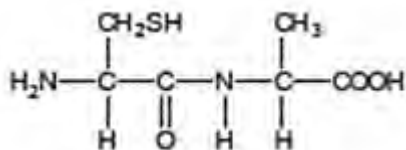
4

(ii) N-methylpropanamide

Not N-methylpropanamide

1

(c)



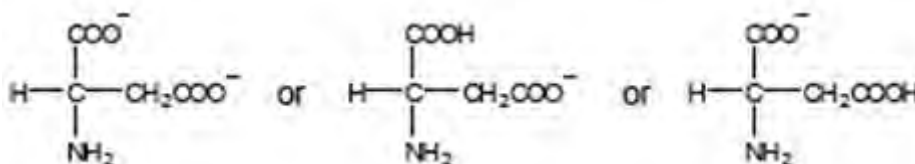
Allow $-\text{CONH}-$ or $-\text{COHN}-$

1

(d) (i) 2-amino-3-hydroxypropanoic acid

1

(ii)



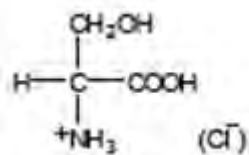
Must be salts of aspartic acid

allow $-\text{CO}_2^-$

allow NH_2-

1

(iii) Penalise use of aspartic acid once in d(iii) and d(iv)



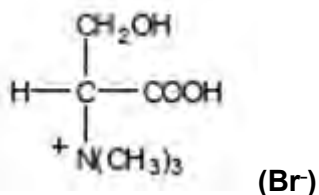
allow $-\text{CO}_2\text{H}$

allow $\text{}^+\text{NH}_3-$

don't penalize position of + on NH_3

1

(iv) Penalise use of aspartic acid once in d(iii) and d(iv)



allow $-\text{CO}_2^-$

must show C-N bond

don't penalize position of + on $\text{N}(\text{CH}_3)_3$

1

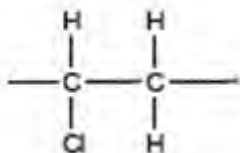
[16]

M3. (a) Benzene-1,2-dicarboxylic acid

Allow 1,2-benzenedicarboxylic acid

1

(b)



Must show all bonds including trailing bonds

Ignore n

1

- (c) (i) $2 \text{C}_2\text{H}_5\text{OH}$
NB Two ethanols

1

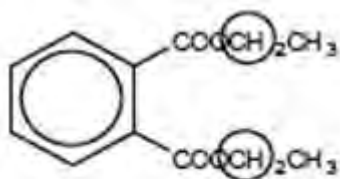
H_2O
but only one water

1

- (ii) 6 or six

1

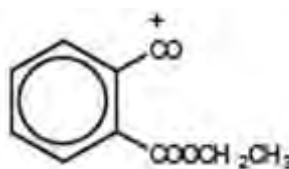
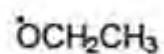
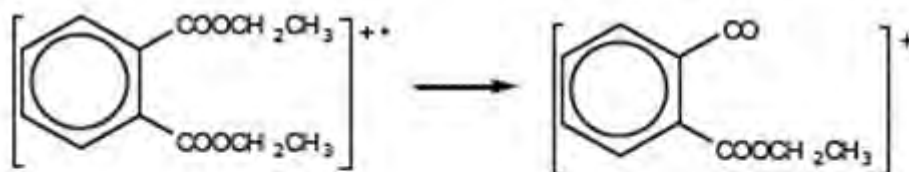
- (iii)



Ignore overlap with O to the left or H to the right, but must only include this one carbon. either or allow both (as they are identical)

1

- (d)



Allow + on C or O in

1

Dot must be on O in radical

1

(e) (i) Rate = $k[\text{DEP}]$

Must have brackets but can be ()

1

(ii) Any **two** of

- experiment repeated/continued over a long period
 - repeated by independent body/other scientists/avoiding bias
 - investigate breakdown products
 - results made public
- Not just repetition*
Ignore animal testing

2 max

[11]